

Historic Observations of the Spectrum of η Carinae

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Abstract

Some long-forgotten spectroscopic observations with the Great Melbourne Telescope (GMT) are described. They show a possible change in the spectrum of Eta Carinae in January 1871, at an inferred phase of 0.02 in the binary orbit of Daminieli et al. (2000). If confirmed, this provides evidence for a 5.5 year periodicity at this epoch. Other early observations recorded near zero phase are described. An ongoing project to revise the light curve of Innes (1903) is also briefly discussed.

1. Introduction

Eta (η) Carinae is one of the most luminous and massive stars in the Galaxy and has a long history as a variable star. Long thought to be single, Daminieli (1996) discovered a 5.52 year periodicity, and since then, there has been increasing evidence for the binary nature of the system at all wavelengths (Abraham & Daminieli 1999, Ishibashi et al. 1999, Daminieli et al. 2000, Feast et al. 2001). Along with narrow “eclipses” superposed on broad photometric maxima at both visual and near infrared wavelengths, the high-excitation spectral lines fade for a few months around the proposed epoch of periastron. Feast et al. (2001) showed that all of the early spectrograms seem to be in a low-excitation state, but it is possible that some lines may vary around phase 0.0 at these early dates.

2. Early Observations

While researching old accounts of Eta's brightness, I have found a possible change in the spectrum dating back to the 19th century. It is well known that Albert Le Sueur used the 48-inch Great Melbourne Telescope (GMT) between November 1869 and January 1870 to visually examine the spectrum of Eta. He noted its bright-line nature and likely identified H α , FeII λ 5018, FeII λ 5169, HeI λ 5876 and H β in emission (Le Sueur 1870a, Walborn & Liller 1977). A sixth line in the blue, possibly H γ , was also strongly suspected (Le Sueur 1874a), as well as a suspicion of numerous absorption lines in good seeing conditions. Other accounts (Le Sueur 1870b, 1874b) give additional details, while further unpublished descriptions by Le Sueur reside in the Australian National Archives, Canberra.

Le Sueur's successor, Farie MacGeorge, also used the GMT to view and delineate the Carina nebula, as well as undertaking spectroscopic observations of both the nebula and Eta itself. On 17 January 1871, he described a significant change in its spectrum (MacGeorge 1874):

Spectrum of nebula very faint, with usual lines ghostly and fitful. Spectrum of η hazy and unsatisfactory, with diffused light, although other stars appear distinct enough. Could not see the slightest appearance of bright lines, but fancied I detected with [a] wide slit absorption bands in position of nebular lines, but too chaotic and indistinct for measurement although attempted frequently.

Next evening (18th January) Mr. Ellery confirmed my observations and verified sketch. Neither he nor Professor Smith, who was also present, *recognised* the spectrum of η when shown in the telescope as the same which they had seen the year before, and could find no bright lines. I again imagined I saw the same ghosts of absorption lines in the positions of the usual bright lines of the nebula.

These observations are at phase 0.02 using the orbit of Damineli et al. (2000), which adopts a slightly revised 5.53 year period; m_v was then about 6.2 (Frew 1998). While it cannot be ruled out that poor transparency or seeing was a contributing factor in this description, it should be emphasized that Ellery, who was the observatory's director and a capable observer in his own right, concurred with MacGeorge. There is no evidence to suggest the speculum mirror had deteriorated at this time, and the detailed descriptions and sketches of the Carina nebula by MacGeorge indicate that the instrument was in good working order. In September 1871, H.C. Russell attempted spectroscopic observations with the 7.25-inch refractor at Sydney Observatory (Russell 1872). He observed the spectrum of the nebula, but was “unable to obtain any spectrum of η Argus itself.”

If the Melbourne observations provide evidence to show that Damineli's ephemeris holds at this early date, then this may constrain the amount of mass loss that occurred during the 1887-95 lesser eruption; perhaps this event was an ordinary SD-phase (van Genderen 2001), rather than a major eruption. Furthermore, it may be worthwhile to re-examine other early spectrograms taken near the time of “eclipse minimum”. Hoffleit (1933) measured the intensities of the brightest emission lines on several objective prism plates taken between 1892 and 1930. On the famous 1893 June 2 plate (X4709) at phase 0.067, she noted a change in some of the line intensities, though Walborn & Liller (1977) offer a contrary opinion. Another spectrogram worth re-examining was taken at Cordoba Observatory (Perrine 1926). This is an objective prism plate at phase 0.99, and should be well within a spectroscopic event. Table 1 includes a brief summary of some of the more interesting observations at early epochs.

Table 1. Early observations around phase 0.0

Observer	Date	Phase	Remarks
MacGeorge	1871.05	0.02	Change in visual spectrum; no emission lines apparent
Thome	1887.6	0.01	Start of lesser eruption; <i>Astr. Nachr.</i> 122, 305 (1889)
<i>Harvard</i>	1893.36	0.06	Objective prism plate B9431; <i>Harv. Ann.</i> 26, 209 (1891)
<i>Harvard</i>	1893.42	0.07	Objective prism plate X4709; <i>Harv. Ann.</i> 28, 175 (1901)
Gill	1899.04	0.08	Objective prism plate; <i>MNRAS</i> 61, 456 (1901)
Perrine	1926.13	0.99	Objective prism plate; <i>PASP</i> 38, 116 (1926)

Curiously, the beginning of the lesser eruption is within a month of a spectroscopic event predicted from Daminieli's ephemeris, and may have been triggered by a close passage of the primary with its proposed companion. According to J. Thome at Cordoba, Eta began to brighten around 1887.6, or phase 0.01. Clerke (1888) observed the spectrum visually with a 7-inch refractor in the early stages of the light maximum (phase = 0.23), and noted an absence of emission lines, but this observation is equivocal owing to the relatively small size of the telescope used. It should be noted that Daminieli (1996) found that the photometric maxima at 1827.0, 1838.0 and 1843.2 are also coincident with his predicted time of zero phase.

3. Future Work

Efforts should be made to see if any of the early spectrograms provide additional data on Eta's behavior during the lesser eruption, while continued searches through observatory archives may reveal other early spectroscopic records. I have also commenced a long-term project (Frew 1998), reducing old published and unpublished estimates of Eta's brightness to the modern m_v system. My goal is to provide an accurate light-curve that supersedes the time-honored effort of Innes (1903). To date, more than 600 visual estimates from nearly 80 observers have been recovered.

Furthermore, a potential gold mine of information would result from the digitizing of the many old photographic plates taken from Cordoba, Harvard, Cape, Union, Sydney, Melbourne and Riverview Observatories. It may be possible to detect brightness changes corresponding to spectroscopic events at these early epochs, while comparing accurate m_{pg} with m_v estimates may better constrain the color evolution of this paradoxical star between 1870 and the present.

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